Science and Industry. By Professor **A. D. Ross**, M.A., D.Sc., F.R.S.E.

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On 30th June last there occurred the centenary of the birth of Baron Sir Ferdinand von Mueller. The event is of special interest to us as our Royal Society has gradually developed from the Mueller Botanical Society—a society named after the distinguished botanist. Von Mueller was born at Rostock and received his education at Kiel. From 1840 to 1847 his time was spent in the investigation of the flora of Schleswig-Holstein. Thereafter he emigrated to Australia owing to hereditary phthisis, both of his parents having died through that disease. For some four years he acted as a druggist's assistant in Adelaide and then secured appointment as Government Botanist. His inclusion as botanist in Gregory's Expedition of 1855-1856 across Northern Australia brought him into prominence, and from 1857 to 1873 he held office as Director of the Melbourne Botanic Garden. Von Mueller was a prolific writer. He had at one time contemplated the issue of a general Flora of Australia, but at the suggestion of Bentham sent his notes on this subject to Kew. His more utilitarian works included illustrated monographs on the *Eucalyptus* and *Acacia*, and his *Census of Australian Plants* was an important contribution to natural science. After holding many prominent offices in scientific societies, including the Presidentship of the Australasian Association for the Advancement of Science, Von Mueller died in Melbourne on 9th October, 1896. Before his death he spent a period studying the flora in the southern part of our State. So it came about that on the formation of a botanical society in Western Australia, in July, 1897, it was given the name of the Mueller Botanical Society. The gradual broadening of its sphere of activity to that which our Royal Society now claims would have been impossible but for the rapid multiplication of specialised societies. To maintain an effective central or co-ordinating society puts a heavy responsibility upon the members, and, despite anything they might attempt, little could be accomplished but for the hearty support of these specialised societies. Therefore it is to-night my pleasant duty to welcome to our meeting delegates from the various scientific, industrial and commercial organisations of Western Australia.

As I complete to-night a two year's occupancy of the presidential chair of this Society, my mind naturally reverts to the winter of 1917, when I was similarly called upon to deliver an address as your retiring President. On that occasion I took as my theme "The State and Science." On glancing over that address a few weeks ago I was struck by the singular appropriateness of the subject even at the present time. Then we were in the midst of the greatest war our world had ever known, and the combatant nations were striving to organise so that they might throw all their weight into the conflict. We thus came to realise the existence of many deficiencies in our boasted civilisation, in our industrial methods and in our commercial enterprises. The time was opportune for reforms. But the exigencies of the situation demanded that it must for the moment be a reorganisation on a war-time basis, and we were left to hope that on the cessation of hostilities we would without delay adapt our reforms so as to make ourselves an efficient nation in the times of peace. In 1917 I said, "A new national spirit has been aroused in the British nation by the war . . .But, if we are to recover and improve our position at the end of the war, that national spirit must be maintained. Unless every man and woman comes to know and feel that industry, agriculture, commerce, shipping and credit are national concerns, and that education is a potent means for the promotion of these objects among others, we shall assuredly fail in the great effort of national recuperation. In plain words, our great firms will not make money, wages will fall, and wage-earners will be out of work."

It was difficult then to realise the turn that events might take. The magnificent performance of Australian troops at Gallipoli and in other theatres of the war, called forth world-wide praise. But it was only towards the end of the conflict that we came to recognise the result of this work of the Australians. An Australian nation had been born. There was no suggestion of any slackening of the bonds of union with the homeland. On the contrary, it was the natural outcome of the growth of a sturdy son of the Mother country. That evolution brought with it recognition of the fact that it was the duty of a youth approaching years of manhood to lean less on parental support. Rather was it a duty to assist the parent by following with some independence in the common pursuit of the same aims and same ideals. Such healthy and commendable independence entails new obligations. During the past few years it has become the duty of Australia to take responsibility for the growth and wise development of her own industries and commerce. Instead of leaning on the home country, rather is it now Australia's duty so to develop her resources that they may be an aid to others of our

race who, immigrating to our shores, seek a new home and steady employment.

In 1917 I stressed the importance of a wise application of science in the development of industry and commerce. Let us look into the position as we find it to-day.

At the outset it will be readily admitted that industries and commercial enterprises to be successful must pay and pay well. The less the financial margin in any undertaking, the less must necessarily be the allocation of funds for those of its agencies which operate for the cheapening and improvement of its technical designs and processes; and, unless those agencies are properly developed and take an important place in an organisation, technical efficiency must suffer, and suffer severely.

And what of science? "Applied science," said Sir Michael Sadler, "was nobly defined in the charter granted in 1828 to the Institution of Civil Engineers as 'The art of directing the great sources of power in nature for the use and convenience of man.' Applied science derives most of its strength from pure science, pure science a part (though only a part) of its vindication and encouragement from applied. The difference between them is less one of subject-matter than of motive. Either isolated from the other is weakened through lack of contact with the characteristic virtues of its opposite. Both may form part of the life-work of a single investigator."

From the position thus stated so clearly by Sir Michael Sadler, it is evident that work in so-called pure science may be as helpful in advancing industry as research in so-called applied science. He would indeed be rash who would venture to predict whether a particular research might or might not prove beneficial in its future applications. The application of X-rays to surgical diagnosis and to therapeutics is the direct outcome of inquiries into the fluorescence of certain rare minerals. Broadcasting, in the same way, owes its existence to the mathematical investigations of Kelvin, Maxwell, and others, in electrostatics and in connection with the oscillatory character of certain electric discharges. Every department of science affords innumerable examples of a similar kind.

Further, the history of invention shows clearly that in regard to new processes and new machines most of the important steps have been taken, not by those engaged in the particular art so revolutionised, but by those whom we may call outsiders. Lord Kelvin's many contributions to navigation and to submarine telegraphy are cases in point. It was the investigations of Sadi Carnot into the nature of heat that led ultimately to the development of heat engines. The conception of the regenerator as adding

to the efficiency of heat engines was due to a Scotch clergyman, the Rev. Robert Stirling. So also, on the other hand, we find that where external contact with industry has been least, improvements have come about very slowly. In a lecture on the Textile Industries given in 1923 by Dr. A. E. Oxley, he deplored the fact that while these industries had been one of the great factors in civilisation, they had not sought nor been offered the help which could be obtained from scientists unconnected with the industries. Practical spinners tell us that as a result the principal machines are undeniably inefficient. The most important machine in spinning is the carding machine, yet, despite the improvements introduced by Bourne, Paul, Arkwright, Evan Leigh, and Walsh, the performance is altogether unsatisfactory. In carded yarns there are too many motes and neps, and those in the industries have failed to eliminate these faults. They have to be content with keeping them within reasonable bounds, and so to-day, as an expert in the trade has put it, "whilst the carding machine is indispensable, it is a failure." I venture to think that it is also because of the lack up to recent years of scientific interest in the matter that we are still using cranks in engines whose form from a mechanical point of view is simply grotesque. It is by the outsider coming in and approaching the long-standing problem in an unconventional manner that the solution is generally attained. Here it is where the trained scientist has his great advantage. He has the basic knowledge that guides him in attacking the problem. James Watt's invention of the separate condenser was brought about by his clear and well founded appreciation of its physical function in preventing waste, waste of steam and therefore waste of coal. In his own words, his object was to keep the cylinder as hot as the steam that entered it. So again it was Sir William Bragg's intimate knowledge of the development of X-ray apparatus and of the penetrating power of the shorter wave-lengths that led him on in his applications of these rays in the examination of metal castings, fire-bricks, etc.

It must always be borne in mind that for the efficient application of science in industry there must be full co-operation between the scientist and the industrialist. The practitioners in the art must undoubtedly have the sounder views regarding the limitations imposed by the conditions under which industrial processes can be conducted. It may not be possible, and if possible it may not be wise, materially to change the current of one industry without taking account of the many conditions, external to that industry but bound up with it in the scheme of production, distribution and utilisation, as that scheme is organised through long years of growth and adjustment. Moreover one must not decry the ability of the truly skilled operative. The success of empiricism in industries is suggestive. It is amazing to find how

successful it has often been, and it is one of the most difficult of problems to ascertain how far variations in raw products will permit the substitution of control by measurement for control by judgment. The researcher's functions are undoubtedly complementary to those of the operative. Science should be the leaven of industry; we must not regard it as the lump.

Clearly the ideal method of getting most out of science in an industry is to establish a research man in the works. It is not sufficient for the manufacturer to ask an outside consulting chemist, physicist or engineer to suggest a remedy for some particular trouble. The difficulties that are apparent are generally purely symptomatic and do not form the true problem to be discussed. Only a full acquaintance with the various processes in the work and the scientific basis of these will enable the scientist to get down to the real nature of the trouble and to offer a solution. The research worker must become an integral part of the works staff. He must live with the work, study it in all its parts, and learn to know and judge the personnel of the concern. How otherwise can he hope to assist the management with proposals for sweeping changes and to receive the support of the staff? How else can he know the conditions under which his proposed remedy will be applied? It is thus evident that at the outset the research worker must be given every scope for getting fully acquainted with the new field of his labours. Those in Universities who direct research students are aware that a very great amount of time is taken up in every research in getting to know the field and nature of the inquiry. It is not uncommon for the actual advance to be made in less than a tenth of the whole time given to the subject. Nine-tenths of the time had of necessity to be devoted to gaining acquaintance with the general literature, previous investigations, and the instrumental equipment. In selecting a research man for industrial concerns experience in the same class of technical work is not necessary, and is often a very great hindrance because the individual comes with fixed ideas. A research man from a rival industrial concern is generally the worst choice. A man who knows his science, who has had some experience in research methods, and who possesses energy, imagination and ambition will soon put himself in the position where he can bring his scientific training into play on the industrial problems.

Before leaving this topic let me add that the research man's work is not finished when a plan of manufacture has been evolved. Mass production brings new and frequent matters for careful examination. It is the unavoidable variation in quality of the raw products in mass production that has ruined so many industrial concerns. The business manager who thinks there is no

further need for scientific oversight after a successful article has been evolved, is inviting disaster. To dispense with the technical adviser is without doubt a penny wise and pound foolish policy.

Having thus discussed the general question of the application of science in industry and commerce, let us return to a consideration of our young Australian nation and of how science is here to foster and to assist in the development of industries. Four main lines of action at once suggest themselves:

(i) Industrial concerns may each individually take such steps towards the application of science in their respective businesses as will result in the solution of all problems where solution is essential.

(ii) Industrial concerns may co-operate in the scientific solution of common difficulties, and this work, carried out for the good of all, may be financed on a co-operative basis, with or without Government assistance.

(iii) State Departments, Universities, Technical and Agricultural Colleges, and other organisations having similar facilities for research may be asked to conduct investigations of these economic problems.

(iv) Special Federal or State Laboratories or Institutes may be set up purely for the discussion of industrial problems.

It will be evident that these various lines of action are not by any means mutually exclusive. Several may operate simultaneously, and that either separately or on some conjoint basis.

A rapid survey is sufficient to show that each of the above methods has its peculiar limitations and disadvantages. Thus, when an industry is young and comparatively undeveloped, it is manifestly impossible for concerns each and severally to undertake the carrying out of all the technological research which is desirable to provide for a healthy growth of the industry. The financial burden is too heavy. To illustrate this point let me quote figures taken from industries associated with my own special subject. The United States of America possesses some highly flourishing electrical corporations. There is the Western Electric Company, a branch of the Western Telegraph Co., which has a huge department devoted to research and development. The staff numbers about 3000 and the annual cost of maintenance is over a million pounds sterling. Again there is the research laboratory of the General Electric Co. at Schnectady which costs in maintenance over a quarter of a million sterling per annum. The provision of such large laboratories is of course far beyond the means of any but the largest

firms. Yet it is to be noted that the firms mentioned find these vast research institutions advisable, indeed necessary, and a paying proposition. The research work is not limited to a pathological study of technical problems. The investigations carried out include very many researches in what is as much pure physics as anything done in the physical laboratories of Harvard or Yale Universities in America, or in the Cavendish Laboratory of the University of Cambridge. The interesting point is that these firms have no difficulty in finding useful practical applications for all the physical discoveries they make. Could there be a more striking proof of the value of co-operation between pure science and industry? As we are at present situated in Australia, we must be content for financial reasons that the research departments of commercial firms should be limited mainly to necessary work in investigating difficulties in routine processes, and to suggesting improvements in details, rather than extend their sphere to the devising of totally new methods.

We therefore turn to the second line of action, viz., co-operation between firms engaged in the same work. A practical difficulty is at once apparent. Firms which are rivals in trade must necessarily feel a certain jealousy towards one another. The heads of the firms may be, and often are, on the best of terms with one another, but directors and shareholders alike must doubt the advisability for their personal good of sharing information regarding their discoveries of improved procedure or methods. It may be possible to reduce this difficulty by getting firms belonging to the same industry to support a research laboratory operating almost as a separate institution and not attached mainly to one individual firm. Or alternatively, the research laboratory for a particular industry may be maintained by the joint financial support of individual firms subsidised by a definite Government grant on a pound for pound or similar basis. The financial support so given by the State is then to some extent a guarantee that results obtained under the scheme in the works of a particular firm are public property and available to all concerned. As a rule, however, such schemes are regarded with a certain amount of suspicion, and I doubt whether they have proved successful in many cases either as regard the quantity or the quality of the work accomplished. It is but fair to say that some industrial firms have taken a commendable national view of their position, and have done much to give help and to make knowledge available to kindred establishments.

We come now to the part which can be taken in this work by Universities, Colleges and State Departments. Take first the case of the educational institutions. Their interest in the matter is two-fold. It is their duty to train men who have the broad

general and the intensive specialised education necessary to enable them to do effective work as research physicist or research chemist attached to a particular industrial concern. These institutions are carrying out this work as thoroughly as the limited funds at their disposal will allow, and I think that Australian firms which have selected Australian graduates as their scientific experts have had little reason to complain of the ability and training of the men they have obtained. But if the Universities and Colleges are to go further than this, and conduct that research which is necessary for the development of industries and the improvement of industrial methods, a new order of things will be required. At present the laboratory provisions are inadequate for such work, the staffs are so fully engaged in teaching that there is too little time for important researches, and the University men have insufficient opportunity for getting that close insight into works practice which is desirable if their investigations are to bear much fruit in industry. Research, if it is to be of value, cannot be relegated to occasional intervals of freedom from other and engrossing duties. It must be taken seriously and such time given to it as allows the investigator to settle down to his work, and to have the details of the inquiry ever in his mind. The same difficulty confronts those in the Public Service. Apart altogether from the endless files and routine operations, there are so many calls on one's time for the dissemination of knowledge of long established facts that comparatively little time may be left for serious research. This is not as it should be. There are in the Public Services of the Australian States men of outstanding ability, who would be able to do much valuable work if they could only in some measure be liberated from a multitude of administrative detail, which might equally well be discharged by someone without the same scientific training. So long as the present system obtains, so long must many Government departments remain bureaux for the issue of information rather than organisations for the acquisition of fresh knowledge. In my opinion there is another factor which has seriously militated against certain Government scientific departments being the highly effective bodies they might and should be. That is the promotion of individuals on account of seniority alone. A man may be an excellent officer in a particular post, but that does not necessarily mean that he should be advanced to a senior position when such becomes vacant. The essential test should always be whether the junior officer has the qualifications to enable him to discharge efficiently the duties of the higher office. If he has, then his experience in the department will undoubtedly make him peculiarly fitted for promotion. A junior officer who has done meritorious work is deserving of reward, and, if he has the necessary qualifications, the natural reward is promotion in grade and pay. But, if he has not the

training and other qualifications desirable in the higher grade, the reward of faithful service and of increased value from experience gained should be higher pay in the same post. Promotion to new duties makes a heavy strain on the best man. Promotion of an unqualified man means either endless worry to the unfortunate being if he is a conscientious individual, or, if he is not conscientious, then the adoption of a "trust to luck" attitude which spells disaster to individual, department, State, and to the fair name of science. In Universities promotion from the position of demonstrator to assistant or lecturer and to professor, is made strictly upon qualifications, and the fact that most people have to move from one institution to another for promotion is proof that seniority is but lightly considered. Yet even the junior assistant in a University has undergone a long and expensive course of training which may in the end carry him far in his profession. I recognise that the public services are in many of their branches recruited by the admission of youths direct from intermediate and secondary schools, but all will agree that such admission of juniors and promotion mainly by seniority must spell disaster, if ample facilities for later training are not granted. Western Australia, I am glad to say, is doing a great deal both in demanding a good standard of education in those taken into the professional branches of its Public Service and in giving facilities for further study. It would however be advantageous if this action were extended and that it were copied in some other parts of the Commonwealth.

We come now to the fourth of the suggested lines of action, viz., the institution of special Federal or State laboratories for industrial research. In certain cases this is, I am convinced, the only solution of the problem. Yet I feel it should not be tried as the general solution. Central laboratories will cost about as much as the special development, equipping and staffing of existing laboratories. It may be the best solution where investigations can be made equally well in any part of the Commonwealth or best in some one locality, and where the results there obtained will be equally applicable to all the States. It is the ideal solution where, in addition, no laboratories are as yet existent which have any facilities for carrying out the work. To hesitate to select one specialised laboratory for the work is merely to encourage each State to take up the research with the resultant loss due to avoidable overlapping. But to establish a special laboratory to carry out work which can be done as well in an existing laboratory is waste. It is wasteful to take such action if some State Department has special facilities for making the investigations. It is at least undesirable to form a special Federal Laboratory for some work if that work could be carried out equally as well

by some University if given the same resources; particularly as the work, if associated with a University, would give perchance excellent opportunities for the training of senior and post graduate students.

In March, 1916, the Federal Government created a temporary Advisory Council of Science and Industry to prepare the way for the creation of a permanent Institute. The Act to establish the Institute was passed in 1920, and the Director was appointed in the following year. During the past few years investigations have been made into certain agricultural, pastoral, and industrial problems, and in a few cases the Institute in its work has been aided financially by certain of the States. In some cases the Institute has co-operated with State Departments or Universities, but the majority of the industrial investigations have been carried out by a staff of special research officers. Prior to the establishment of the permanent Institute there had been in each State Advisory Committees which reported to the central Advisory Council. The Act of 1920 provided for the establishment of similar committees, but no action has been taken under this clause, with the result that the former committees automatically lapsed. Likewise a provision in the Act for grants to encourage training in research has remained inoperative. These both appear to me to be regrettable omissions. It is essential for effective work that such a Federal institution should be in the closest possible touch with the leaders in industry and with the men of science in the individual States. Again the carrying out of industrial research is dependent on the training of research workers and their initiation into specialised problems by employment on minor problems. This has been recognised by the British Department of Scientific and Industrial Research which was created in 1915. For the year 1923-24 out of a vote of £277,000, no less than £41,000 was expended in grants for pure scientific research in Universities. The Carnegie Institution of Washington has likewise attempted to train research workers by having a graded system of graduate students, research associates and research officers. The Mellon Institute of Industrial Research in Pittsburg trains men for similar work. It operates on the system that every individual or company desiring attention directed to a particular problem must provide funds for a Fellowship to train a man for industrial research. Eighty-three Fellowships were thus in operation in the year 1923-24. Other national research organisations have made similar provisions for training investigators, and nothing but good has come from such provision.

As you are all aware, there is at present a move to reorganise the Federal Institute. A conference, called in May by the Prime Minister, has discussed proposals for the constitution of the Insti-

tute and for its programme of inquiry. These are now before the Federal Cabinet, and it is expected that a Bill will be introduced at an early date for the amendment of the Act of 1920 which laid down the original constitution of the Institute.

There are several matters which in my opinion are essential for the success of the reorganised Institute.

In the first place the various States should be allotted an important share in the direction of the Institute and in the planning of the research investigations. If advisory committees are formed in each State, such Committees will be able to assist in no small measure in assessing the relative importance of problems requiring solution in their respective States. The personnel of such Committees need not necessarily be made up mainly of those who are likely to engage in industrial research. Indeed it may be that such persons would be more apt to be biassed in favour of some particular branch of applied science than those who, while well versed in general science or in the needs of developing industries, look at the matter with less personal interest. These State Committees could then send representatives to form a central Federal Executive or Council. In my opinion it is essential that some such body, truly representative of all the States, should have definite executive as distinct from merely advisory functions; that, in fact, it should be in control of the scheme, subject of course to the decisions of the Federal Cabinet or Minister in Charge. As such Federal Councils can meet only three or four times a year a Chief Executive Officer would be necessary to carry out the decisions of the Council and to act in all urgent matters which may emerge between meetings.

In addition there will be required men who will organise and superintend the researches. It will be undesirable to overload the scheme at the outset with too many men whose function would be to direct research rather than to carry out the detailed investigations. At the same time a scheme should be adopted which will be capable of development and expansion as the work of the Institute justifies further expenditure. The Carnegie Institution of Washington conducts its inquiries in many great departments. Each is under the control of a scientific expert, a specialist who organises the research in his department and selects and supervises his research assistants. The allocation in due proportion between the several departments of the available funds of the Carnegie Institution lies largely in the control of a President, a man of sound scientific training and with considerable administrative ability. Could not something on similar lines be our goal in Australia? One might begin with two organisers of research, one a man with qualifications in natural science, the other in chemistry and physics or engineering. As time went on these duties

would be subdivided, such subdivision depending on the urgency of problems awaiting solution and upon the financial gain to our nation of work accomplished by the Institute or under its aegis. It might not be long until such branches as Agriculture, Entomology, Forestry, and Veterinary Science called for separate and individual treatment under the general direction of a special organiser.

When it is decided to take up a particular line of research I anticipate that the existing method will be followed of appointing an Advisory Committee of experts in the special subject of inquiry. In this way the actual investigators will be given the maximum amount of help and the various interests particularly concerned in the research will be kept in touch with its progress. Such a Committee of experts in consultation with the central Council will also be in a position to decide the best means of conducting the investigation. In many cases it may be necessary to do the work in a special laboratory of the Institute. In others, however, it should be possible to make use of existing State laboratories whether attached to Universities, Technical Colleges or Government Departments. Only by so avoiding duplication of laboratories will the scheme be financially efficient, and only by so making use wherever possible of State Institutions will the interest and helpful co-operation of the States be maintained. In some cases where the investigation has to be carried out on a full works scale it may be possible to carry it out in some industrial factory. Similarly it will often happen that some existing laboratory can at low cost be extended to enable it to deal with a particular problem, and in such instances it will surely be preferable to adopt this procedure rather than to spend a larger sum on equipping a special laboratory.

Here let me emphasise the fact that the most vital need we have at present in Australia is for more trained investigators. No scheme for benefitting industry through science can afford to ignore this fact. I have already pointed out that the British Department of Scientific and Industrial Research devotes about 15 per cent of its funds to grants in aid of research. In Australia at least 20 per cent of the available money should be set aside at the outset for this purpose. There are two reasons for adopting this course. I have already referred to one, viz. the necessity of training investigators. The second is no less important. One cannot always obtain by order the solution of a problem. If the Institute is going to initiate research only when difficulties in commerce and industry call for aid, then I am afraid the percentage of successes among the problems taken up may be low. As Sempronius was advised: "'Tis not in mortals to command success." There are however in Australia many qualified

investigators in scientific departments and institutions who, as a result of special training or other circumstances, have become interested in a particular line of inquiry. But, owing to lack of funds, the research lies untouched or makes little progress. I would suggest that if the Institute gave grants in aid of such investigations there would be a quick and abundant harvest. The Carnegie Trust for the Universities of Scotland has now made grants in this way for a quarter of a century and the results have been excellent. I am convinced that the effect in Australia of such a scheme would be no less beneficial.

There are some I know who argue that all the work of the Australian Institute, or at any rate by far the greater part of it, should be carried out in the Institute's own laboratories. They say that our University staffs have no time for research. I feel sure that time will be found if opportunity for the work is otherwise forthcoming. Moreover I say without fear of contradiction that the teaching staffs of our Australian Universities will never be in the proper position to give the best instruction to their students unless they are enabled through research to keep in the closest touch with the industries and commercial undertakings in our Commonwealth. Anything which is going to bring our University students, our young men and young women, into a knowledge of research methods is going to raise greatly the scientific standard in Australia. Sir J. J. Thompson has said "I think that every scientific worker should undergo a year's training in research, not merely because in many cases the business of his life would be research, but also because of the effect it has upon his mental development and character. I have had many opportunities of watching the change produced in men by a year's research. The results are striking. It increases a man's independence of thought, it increases his resource, it increases his critical power, and it increases his enthusiasm; in fact, it raises him from intellectual adolescence to intellectual manhood."

Much scientific work remains to be done here in Australia. Ours is a vast continent, the population is small, but the possibilities of future development in commerce and industry are enormous. Wisely directed these developments may make this fair land a great and prosperous possession for the British race. On the other hand, developments along faulty and ill-considered lines would lead to reverses, loss and ultimate disaster. Science can play an important part in guiding our destiny. May it be the work of every scientist in our Commonwealth to do his or her share that Australia may advance.

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